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Cost Growth in Major Weapon Procurement Programs

Presentation to the 38th Annual DoD Cost
Analysis Symposium
Williamsburg, VA
February 16, 2005

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Topics

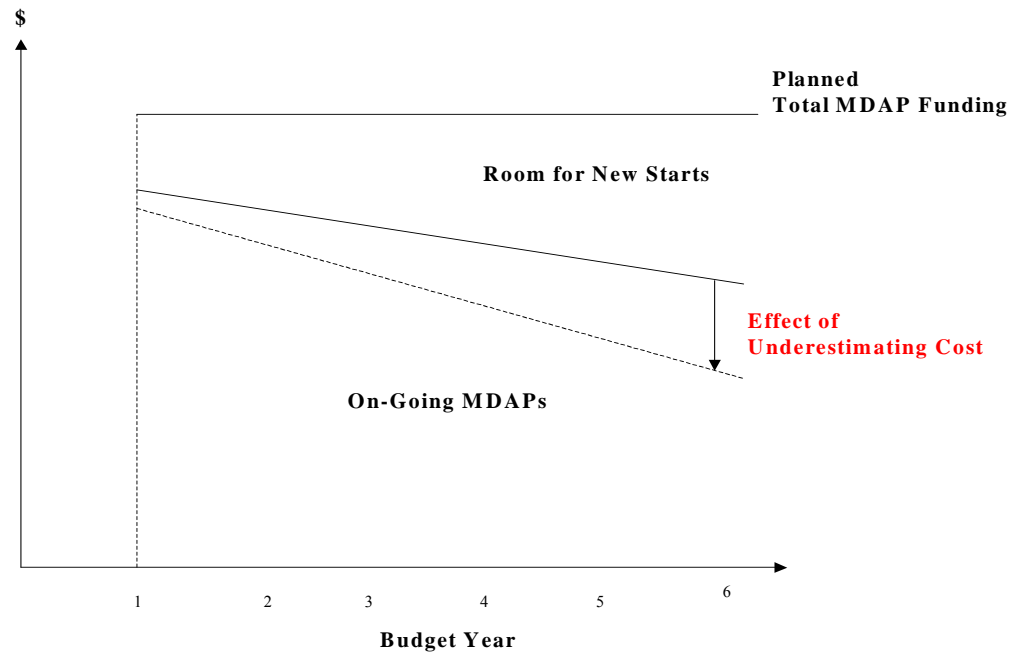
- Efficiency Rationale for Budgeting Weapon System Procurements to Most Likely Cost.
- Statistical Evidence on Some Common Explanations of Cost Growth.
- Causes of Extreme Cost Growth.
- Recommendations



Efficiency Rationale for Budgeting to Realistic Cost Estimates

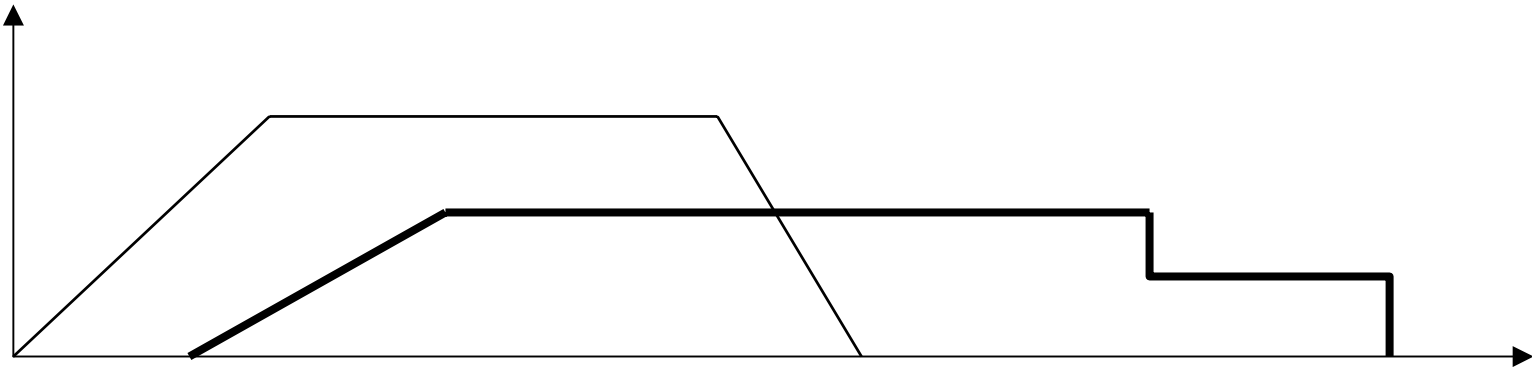


UNDERESTIMATION OF COSTS AND APPARENT SCOPE FOR NEW STARTS



Underestimation of cost typically leads to program stretches.

Stretch of a Production Program



- Production profile planned at the start of SDD
- Production profile executed

Slower production ramp.
Lower maximum buy rate.
Production for more years.
Increased payment of overhead costs.

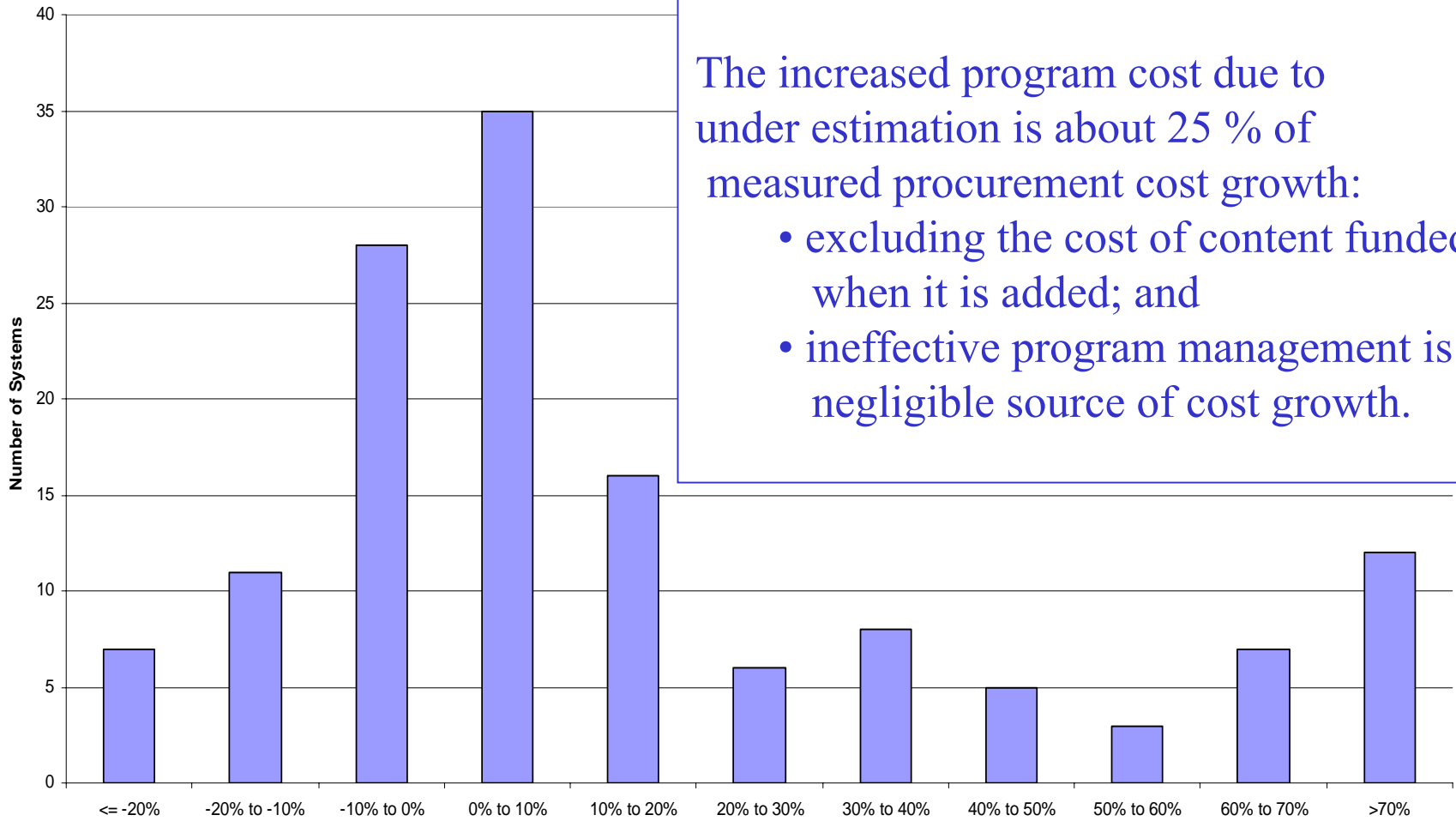


Step 1--Effect of an Unrealistic Budget on the Cost of a Single Program

- **Problem:** Compute the increase in cost of a program begun with an unrealistically low budget, assuming the program is stretched to stay within the previously established annual funding limit.
- **Cost Assumption:** The program's direct costs are independent of the annual production rate.
- **Derived Rule of Thumb:** For each 10% the total funding requirements of the program are under estimated, stretches will increase its final costs by about 3%.



Step 2—Connect to the Cost Growth Data



DISTRIBUTION OF THE *MISTAKES* COMPONENT OF PROCUREMENT COST GROWTH
from the PA&E Cost Growth Database.



Step 3—Application to the DoD Procurement Program over 1970-1997

- **Approach:** The estimate takes crude account of the following:
 1. The Reagan buildup—added funds avoided cost growth and stretches that would otherwise have occurred.
 2. The end of the Cold War—budget cuts and program cancellations not due to initial underestimates of budgets.
 3. Application of funds from programs that under run.
 4. Effects of stretches on learning curve slopes.
- **Results:** Over the period 1970-1997, unrealistic initial budgets were about equivalent in effect to an annual tax on the DoD procurement program of 2% to 8%.



Implications

- Stretches due to unrealistic budgeting seemed to have added VERY roughly 2% to 8% to the cost of acquiring systems that passed MS II between 1973 and 1997.
- This does *NOT* mean that 2% to 8% more program could have been included in any given year within that year's budget.
- Budgeting to realistic cost estimates would result in:
 - Fewer major programs in development and procurement at each point in time.
 - More rapid completion of programs (relative to historical norms).
- The choice then is between:
 - More rapid deployment of new systems (realistic budgets); or
 - More systems in development and procurement (initial budgets unrealistic in a significant proportion of cases.)



Statistical Evidence on Some Common Explanations of Cost Growth



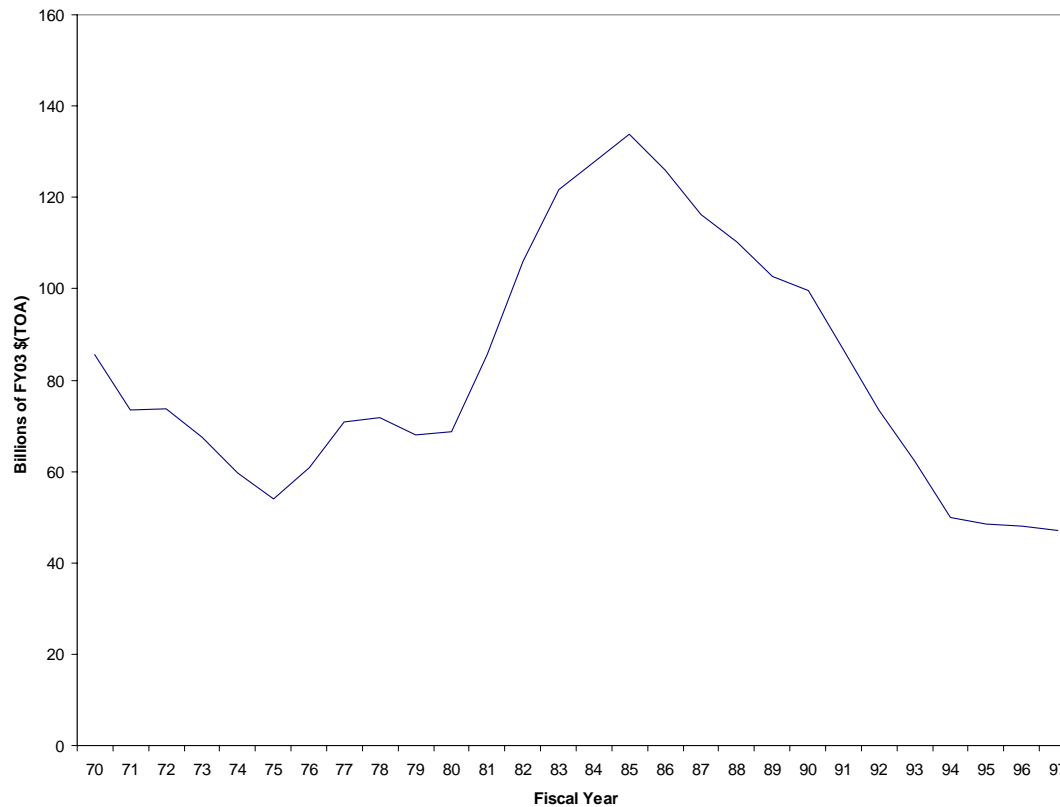
Overview of the Analysis

- Data used attempted “apples-to-apples” computation of cost growth from the MS II baseline.
- Considered five sets of factors that influence observed cost growth:
 - Budget strategy;
 - Effectiveness of the independent costing process;
 - Degree of certainty in the cost estimate;
 - Effectiveness of program management;
 - Acquisition reform.
- Measurable indicators of each of these identified and included in a single linear equation (with 17 independent variables.)
- The dependent variable was cost growth from the MS II baseline.
- Parameters of the equation were estimated using data for 138 systems that passed MS II between 1970 and 1997 inclusive.



Example 1—DoD PROCUREMENT BUDGET FY1970 – FY1997

(Total Obligational Authority in Billions of FY2003 dollars)



Source: U.S. Department of Defense, Office of the Under Secretary of Defense (Comptroller),
National Defense Budget Estimates for FY2003 Budget, March 2002, Table 6-1.



ESTIMATED EFFECTS OF VARIABLES INFLUENCING PROPENSITY TOWARDS OPTIMISTIC COSTING

Variable	Definition	Coefficient (t statistic)
Intercept		1.356** (10.105)
A	Army programs: 1 for Army program, Ø for all others	0.232** (2.861)
AF	Air Force programs: 1 for Air Force programs, Ø for all others	0.063 (0.871)
BUDGET	Marker of periods of “tight” procurement budget 1:1970-1980, 1989-2001; Ø otherwise	-0.017 (-0.176)
P\$	Constant dollar size of procurement program planned at MSII FY2002 dollars	-2.5E-06 (-0.783)

† significant at the 10% level

* significant at the 5% level

** significant at the 1% level



Example 2--COST ESTIMATION REGIMES, 1970-1997

- Pre-FY1974*—no OSD review in the acquisition process of Service cost estimates for MDAPs.
- FY1974-FY1983—OSD requires independent cost estimates at MS II, MS IIIA, and MS III; CAIG and the Services share responsibility.
- FY1984-FY1992—The Congress requires independent cost estimates at MS II and MS IIIA or MS III; CAIG and the Services continue to share responsibility.
- FY1992—IG report on independent costing issued in January 1992; CAIG assumes responsibility for cost estimates required by statute.

* The changes were directed by the Secretary of Defense in January 1972, but had little effect on cost estimates that were already in process at that time.



ESTIMATED EFFECTS OF CHANGES IN THE COST ESTIMATING PROCESS

Variable	Definition	Coefficient (t statistic)
COSTI	early CAIG 1:1974-1983, Ø: elsewhere	-0.267* (-2.465)
COSTII	post statute CAIG 1:1984-1992, Ø: elsewhere	-0.608** (-2.700)
COSTIII	post IG report CAIG 1:1993- , Ø: 1992 and earlier	-0.500 (-2.535)

† significant at the 10% level

* significant at the 5% level

** significant at the 1% level



CONCLUSIONS OF THE STATISTICAL ANALYSIS

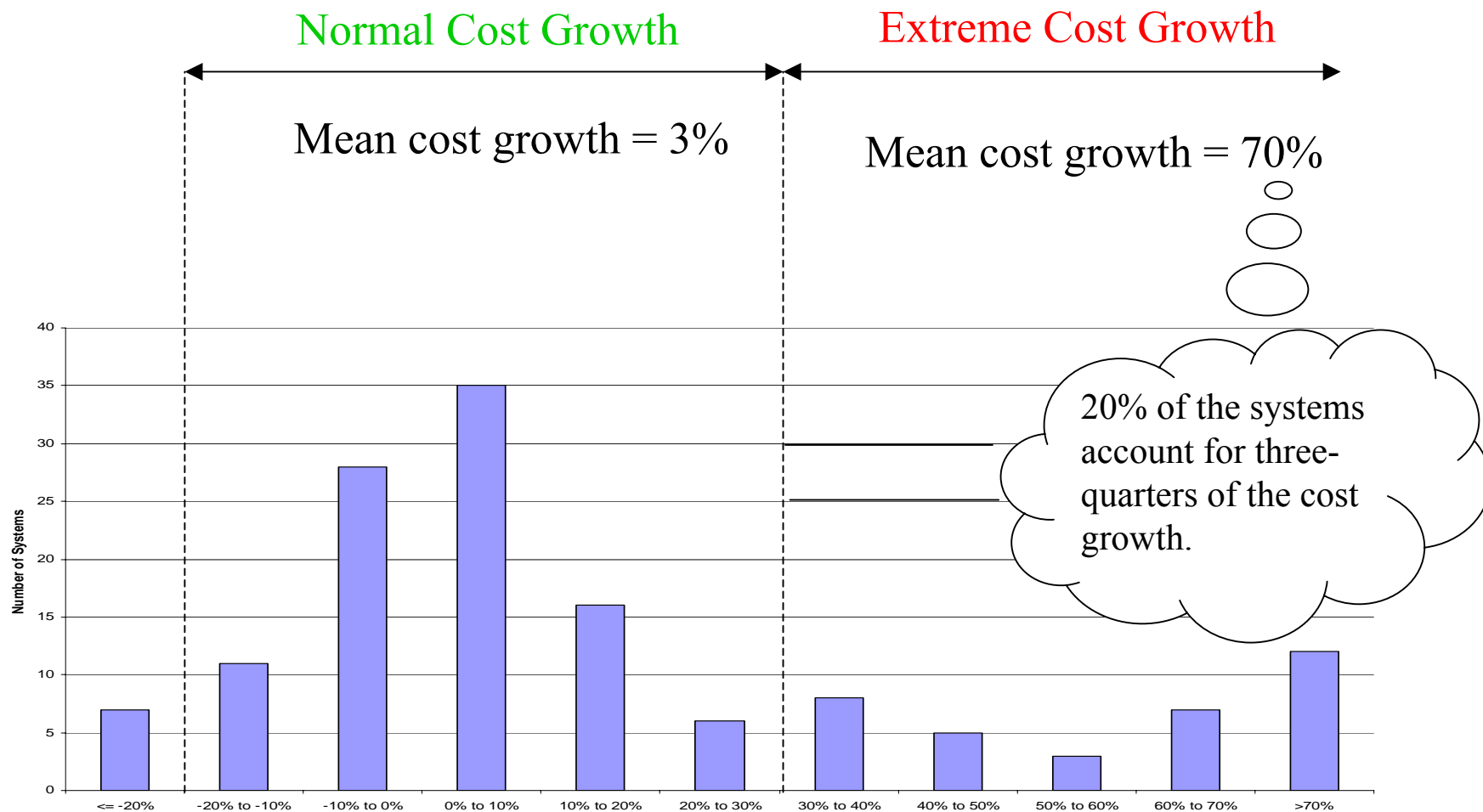
- Army prefers more optimistic pricing than do Navy and Air Force, but changes linked to budget stringency or system characteristics do not seem to be an important explanation of cost growth for any of the Services.
- Stringency with which policy on realistic costing is applied matters.
- Strengthening of the independent cost process has been associated with less cost growth.
- Quality of information also associated with less cost growth..
- Change to Program Executive Officer management structure may be associated with increased cost growth.

Estimated equation accounts for only about 30 percent of the variance in the cost growth data.

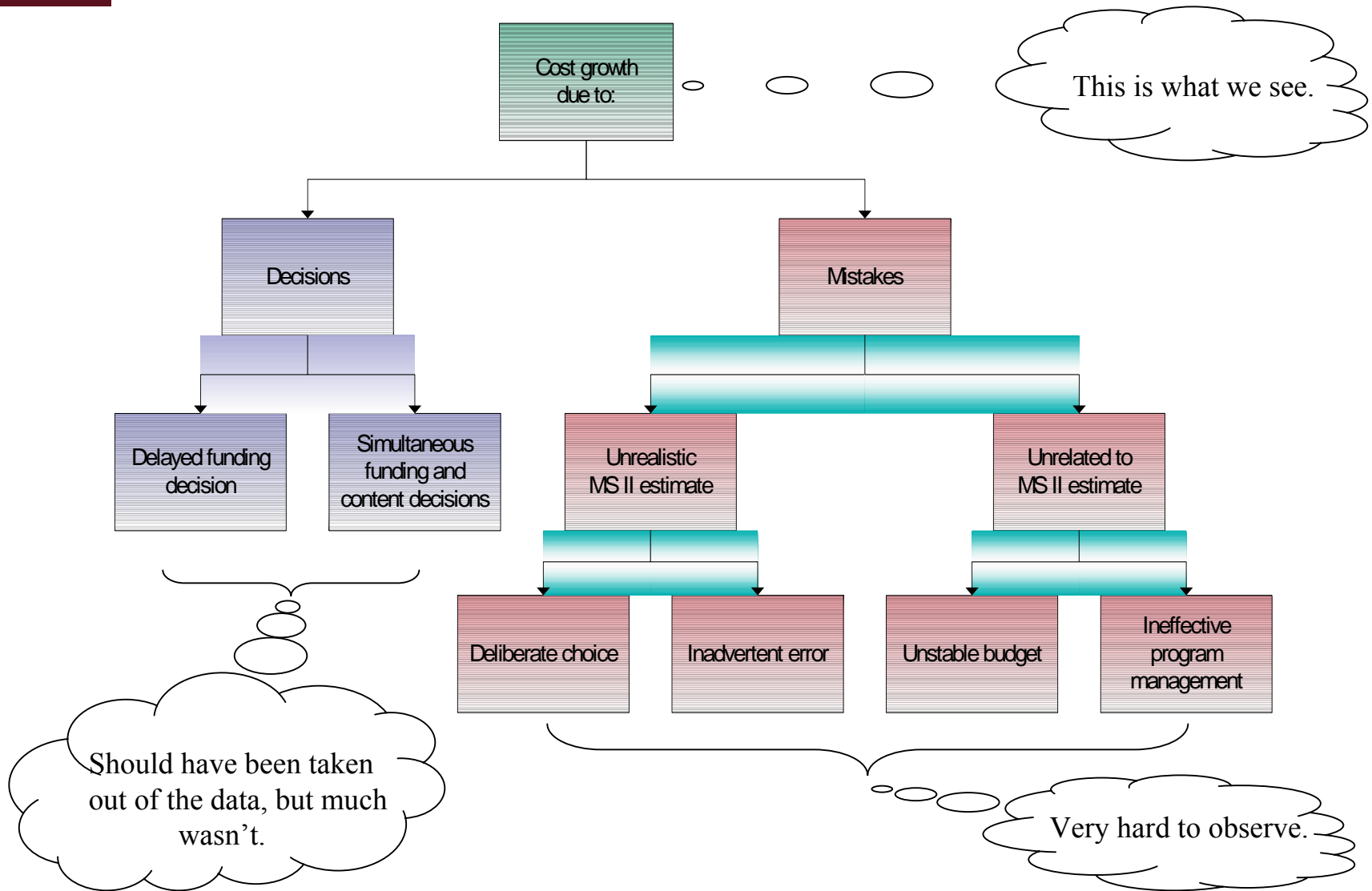


Causes of Extreme Growth in Procurement Cost

What Needs to be Explained



COST GROWTH GATES





Systems with a *Mistakes* Component of Procurement Cost Growth of at Least 30 Percent

Army

SADARM 155mm Projectile
FIM-92 Missile
USQ-84V SOTAS
M2/M# Bradley FVS
MIM-104 PAC-3
AH-64D Apache Airframe
FMTV
FGM-148A Javelin
UH-60A Blackhawk
JTUAV Short Range Hunter

19 of 40 systems

AH-64 Apache
M1 Abrams Tank
ATACMS P3I (BAT)
M712 CLGP Cannon Launched Copperhead
ATTCS ASAS Block II/III
ALQ-212(V) ARIRCM/CMWS
ATCCS FAAD C2I
ATACMS Block II/IIA
M2/M3 Bradley FVS Upgrade

Navy

NATO PHM Pegasus Class
T-45 Goshawk Training System
AGM-84 Harpoon

5 of 56 systems

SQR-19 TACTAS
Navy Area TBMD

Air Force

E-3 Sentry AWACS RSIP
JSTARS USAF
DSCS-III
BGM-108G Tomahawk GLCM
AIM-9L
T-6A JPATS

11 of 42 systems

Global Broadcast System
C-17A Globemaster
C-130J Hercules
LGM-30 Minuteman III GRP
F-15 Eagle



SOTAS

Example of Post-EMD, Pre-Full Rate System Changes

- SOTAS as proposed by the Army was a mechanically steered radar, mounted on a UH-60, with an anti-jam data link.
 - SOTAS began as a highly successful ATD.
 - It came to a MS II in November 1978.
- An OSD official proposed, and the Army agreed, that electronic steering be incorporated in the SOTAS EMD and procurement.
- New bids were quickly obtained for a SOTAS with electronic steering.
- Incorporation of electronic steering was a major development challenge and had similarly large implications for cost.
- The procurement cost estimate was revised little if at all until more than 2 years into the program. The new estimate was prepared for the DSARC review that led to cancellation of SOTAs.



Mistakes Component of Procurement Cost Growth on Modification Programs in Two Periods

	1970-1988			1989-1997		
	≤30%	≥30%	Total	≤30%	≥30%	Total
Army	2	0	2	3	4	7
Navy	17	0	17	7	0	7
Air Force	8	2	10	1	3	6
Total	27	2	29	11	7	18

Source: OSD PA&E Cost Growth Database.



Mistakes Component of Cost Growth on Development (EMD) and Procurement (percent)

	EMD	Procurement
Army	26	40
Navy	10	6
Air Force	27	16

Source: OSD PA&E Cost Growth Database



Causes of Extreme Growth in Procurement Costs*

• Changes in requirements after MS II	14
• Fixed price EMD and production contract obtained through competition	6
• Inadvertently poor costing not ruled out	<u>15</u>
	35

* McNicol, *op. cit.*



Recommendations



RECOMMENDATIONS

1. Avoid use of production commitments obtained as part of a competitive EMD award.
 - Such commitments are successful only if bidders believe that DoD will hold them to their bids.
 - Creditable only if requirements are set and funding secure.
 - Those conditions have rarely been met for MDAPs.
2. Require prior USD(AT&L) approval of major post-EMD but pre-full rate changes in system capabilities.
 - New acquisition process (spiral development) effectively does this.
 - What in previous years were baseline changes should go into successive spirals.
3. Start preparatory work on “hard” cost estimates much sooner than currently required by acquisition regulations.
 - Initiate early studies of crucial issues—e.g., commonality on JSF;
 - At MS A think hard about what data should be collected and/or cost demonstrations conducted.



Backup



Mistakes Component of Growth in Procurement Cost from the Milestone II Baseline

	Fiscal Years				
Cost Growth	1970–73	1974–83	1984–92	1993–97	1970–97
≥ 30%					
Number of Systems	6	8	11	10	35
Group Aver. Cost Growth (%)	80	69	86	46	70
-20% to 30%					
Number of Systems	8	30	43	15	96
Group Aver. Cost Growth (%)	3	5	1	5	3
≤ -20%					
Number of Systems	1	2	3	1	7
Group Aver. Cost Growth (%)	-41	-33	-27	-54	-35
Total Sample	15	40	57	26	138
Number of Systems	15	40	57	26	138
Average Cost Growth (%)	30	16	16	18	18

Source: McNicol, *op. cit.*, Table 8, p. 18. The underlying data are from the PA&E cost growth database.



Does DoD Get a Passing Grade on Procurement Cost Growth?

	Pre-CAIG ^a	1974-83	1984-92	1993-97
Average Cost Growth	30%	16%	16%	18%
No. of Systems	15	40	57	26
No. \geq 30% Cost Growth	6 (40%)	8 (20%)	11 (19%)	10 (38%)

a FY 1970-73. The CAIG was established in mid FY 1972, but FY 1974 was the first full year it was able to influence estimates for milestone reviews.

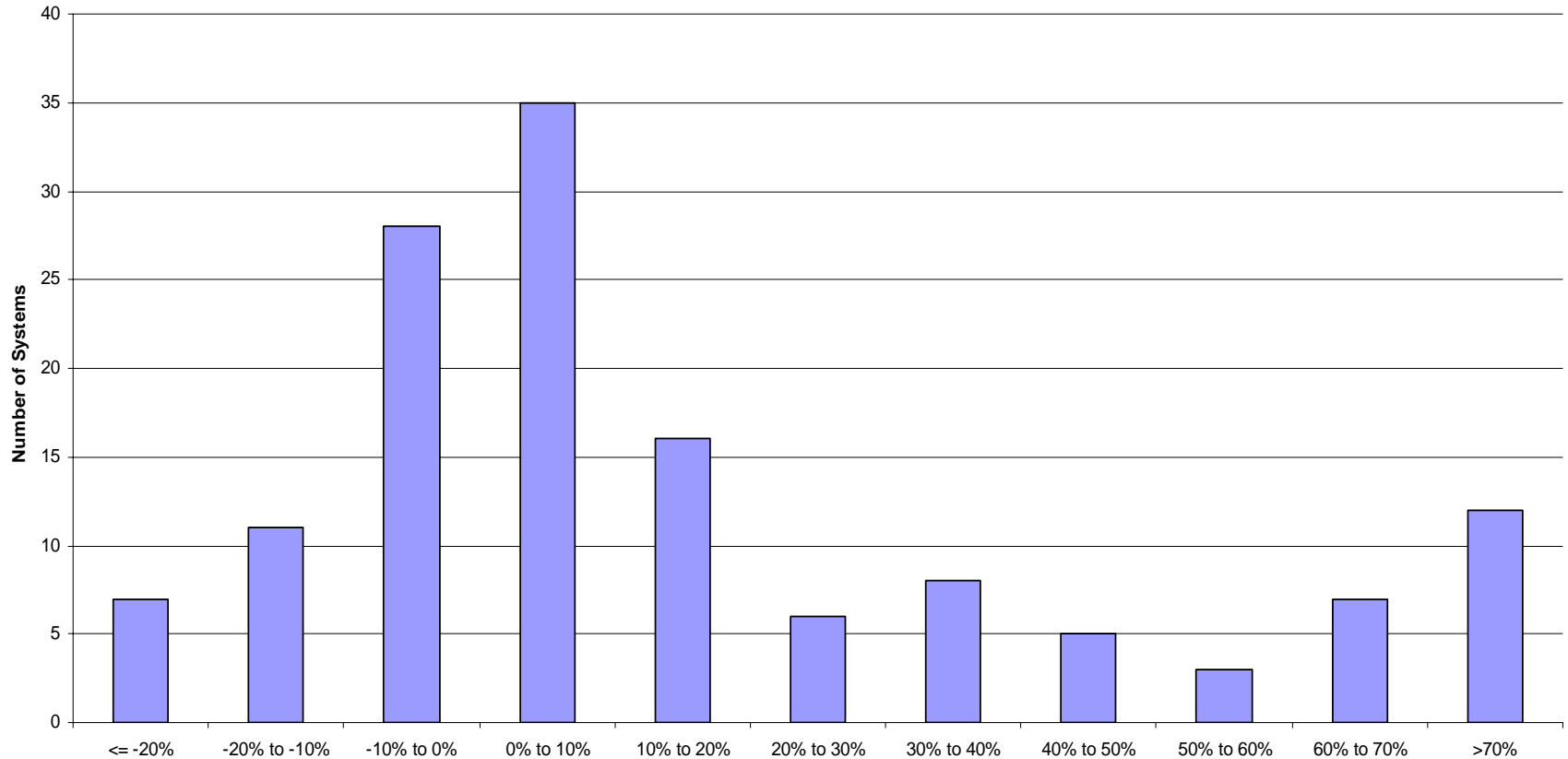
b PA&E data extracted from SARs. Average growth in procurement cost in constant dollars, normalized to Milestone II Inventory objective and partially normalized for exogenous changes in program content.

Jury is still out: cost growth on the typical major system is acceptable, but 20% to 25% of major procurements exhibit cost growth in excess of what is acceptable.



DISTRIBUTION OF THE *MISTAKES* COMPONENT OF PROCUREMENT COST GROWTH—PA&E Data

138 Systems, CGMP





Measurement of Cost Growth

- Cost growth computed in terms of the Engineering and Manufacturing Development (EMD) (Milestone II) baseline. Computed separately for development and procurement.
- The underlying data are drawn from the Selected Acquisition Reports (SARs) for each of 138 major acquisitions.
- PA&E made the following adjustments to the data:
 - Restated baselines and actual costs in constant dollars;
 - Restated actual costs in terms of the total inventory objective established at MS II;
 - Removed cost growth clearly due to exogenous increases in program content.

$$\% \text{ cost growth} = \{\text{actual cost} \div \text{MS II estimate}\} \times 100\% - 100\%$$



DATA USED IN THE STUDY

- Selected Acquisition Reports (SARs) often do not separate costs of post-MS II additions to programs from errors in forecasts of the cost of the MS II content.
- PA&E has out for beta-test data that separate for 138 systems cost growth due to *decisions* on program content or acquisition strategy from “*mistakes*” in forecasting costs.
- Examples of *decisions*:
 - Across-the-board budget cut forces lower production rate;
 - Costs associated with incorporating capabilities beyond those required at MS II.
- Examples of *mistakes*:
 - Increase in flyaway cost due to underestimation of manufacturing hours.
 - Delay in start of production;
 - Cost growth induced by changes required to correct a *mistake*.

NEW DATA ARE BETTER, BUT NOT GREAT



**AVERAGE GROWTH IN MDAP COST
FROM MS II DUE TO DECISIONS
AND *MISTAKES*—*PA&E Data***

	(Percent)	
	Development	Procurement
<i>Decisions</i>	21	10
<i>Mistakes</i>	24	18
Total	45	28

Source: Preliminary DoD data.



Factors Contributing to Extreme Cost Growth

Contracts that Invite a Buy-in

M1 Abrams Tank
T-45 Goshawk Training System
AGM-84A Harpoon *
JSTARS
T-6A JPATS
C-17A Globemaster

* 1970 contract.

Post EMD, Pre Full Rate System Changes

SADARM 155mm Projectile
FIM-92 Stinger
USQ-84(V) SOTAS
M2/M3 Bradley FVS
AH-64 Apache
ATACMS Block II/III
ATACMS P3I (BAT)
NATO PHM Pegasus Class
ATCCS ASAS Block II/III*
ALQ-212(V) ATIRCMS/CMWS*
ATACMS Block II/IIA*
M2/M3 Bradley FVS Upgrade*
E-3 Sentry AWACS RSIP*
C-130J Hercules*
LGM Minuteman III GRP*
* Post-1988 modification program

Presumed Inadvertent Costing Errors

FMTV
AH-64D Apache Airframe
FGM-148A Javelin
JTUAV Short Range Hunter
ATCCS FAAD C2I
SQR-19 TACTAS
DSCS-III
BGM-109G Tomahawk GLCM
Global Broadcast System
F-15 Eagle
Navy TBMD
AIM- 9L
UH-60A*
M712 Cannon Launched*
Copperhead*
* Few useful costing precedents.